Back pain in patients with degenerative spine disease and intradural spinal tumor: What to treat? When to treat?

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Abstract: BACKGROUND: Back pain is common in industrialized countries and one of the most frequent causes of work incapacity. Successful treatment is, therefore, not only important for improving the symptoms and the quality of life of these patients but also for socioeconomic reasons. Back pain is frequently caused by degenerative spine disease. Intradural spinal tumors are rare with an annual incidence of 2-4/1,00,000 and are mostly associated with neurological deficits and radicular and nocturnal pain. Back pain is not commonly described as a concomitant symptom, such that in patients with both a tumor and degenerative spine disease, any back pain is typically attributed to the degeneration rather than the tumor. OBJECTIVE: The aim of the present retrospective investigation was to study and analyze the impact of microsurgery on back/neck pain in patients with intradural spinal tumor in the presence of degenerative spinal disease in adjacent spinal segments. METHODS: Fifty-eight consecutive patients underwent microsurgical, intradural tumor surgery using a standardized protocol assisted by multimodal intraoperative neuromonitoring. Clinical symptoms, complications and surgery characteristics were documented. Standardized questionnaires were used to measure outcome from the surgeon's and the patient's perspectives (Spine Tango Registry and Core Outcome Measures Index). Follow-up included clinical and neuroradiological examinations 6 weeks, 3 months and 1 year postoperatively. RESULTS: Back/neck pain as a leading symptom and coexisting degenerative spine disease was present in 27/58 (47 %) of the tumor patients, and these comprised to group under study. Patients underwent tumor surgery only, without addressing the degenerative spinal disease. Remission rate after tumor removal was 85 %. There were no major surgical complications. Back/neck pain as the leading symptom was eradicated in 67 % of patients. There were 7 % of patients who required further invasive therapy for their degenerative spinal disease. CONCLUSIONS: Intradural spinal tumor surgery improves back/neck pain in patients with coexisting severe degenerative spinal disease. Intradural spinal tumors seem to be the only cause of back/neck pain more often than appreciated. In these patients suffering from both pathologies, there is a higher risk of surgical overtreatment than undertreatment. Therefore, elaborate clinical and radiological examinations should be performed preoperatively and the indication for stabilization/fusion should be discussed carefully in patients foreseen for first time intradural tumor surgery.

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1. Abstract:

Background:

Back pain is common in industrialized countries and one of the most frequent causes of work incapacity. Successful treatment is therefore not only important for improving the symptoms and the quality of life of these patients but also for socioeconomic reasons. Back pain is frequently caused by degenerative spine disease.

Intradural spinal tumors are rare with an annual incidence of 2-4/100'000 and are mostly associated with neurological deficits and radicular and nocturnal pain. Back pain is not commonly described as a concomitant symptom, such that in patients with both a tumor and degenerative spine disease, any back pain is typically attributed to the degeneration rather than the tumor.

Objective:

The aim of the present retrospective investigation was to study and analyze the impact of microsurgery on back/neck pain in patients with intradural spinal tumor in the presence of degenerative spinal disease in adjacent spinal segments.

Methods:

58 consecutive patients underwent microsurgical, intradural tumor surgery using a standardized protocol assisted by multimodal intraoperative neuromonitoring. Clinical symptoms, complications and surgery characteristics were documented. Standardized questionnaires were used to measure outcome from the surgeon's and the patient's perspectives (Spine Tango Registry and Core Outcome Measures Index (COMI)). Follow-up included clinical and neuroradiological examinations 6 weeks, 3 months and 1 year postoperatively.

Results:

Back/neck pain as a leading symptom and coexisting degenerative spine disease was present in 27/58 (47%) of the tumor patients. Patients underwent tumor surgery only, without addressing the degenerative spinal disease. Remission rate after tumor removal was 85%. There were no major surgical complications. Back/neck pain as the leading

symptom was eradicated in 67% of patients. There were 7% of patients who required further invasive therapy for their degenerative spinal disease.

Conclusions:

Intradural spinal tumor surgery improves back/neck pain in patients with coexisting severe degenerative spinal disease. Intradural spinal tumors seem to be the only cause of back/neck pain more often than appreciated. In these patients suffering from both pathologies, there is a higher risk of surgical overtreatment than undertreatment. Therefore elaborate clinical and radiological examinations should be performed preoperatively and the indication for stabilization/fusion should be discussed carefully in patients foreseen for first time intradural tumor surgery.

Keywords:

Intradural spinal tumor, degenerative disc disease, neurinoma, meningeoma, treatment strategies, COMI, Spine Tango, outcome

2. Introduction:

Back/neck pain is common in industrialized countries with a prevalence of up to 90% [1]. It is the most frequently reported musculoskeletal problem and the third most common symptom of any kind making it one of the most common causes of work incapacity [1]. Successful treatment is hence important not only to minimize individual suffering but also for socioeconomic reasons. Underlying pathologies are mostly of degenerative origin and include spinal canal stenosis, facet joint arthrosis, degenerative disc disease, degenerative spondylolisthesis and degenerative scoliosis. Surgical treatment of back/neck pain typically includes endoscopic or microsurgical discectomy, spinal canal decompression and fusion with or without instrumentation, but even in well selected patients, surgical treatment may fail in up to 32% of patients [2].

Intradural spinal tumors are rare with an annual incidence of 2-4/100'000 and are mostly associated with neurological deficits and radicular and nocturnal pain [3,4]. Back/neck pain is not commonly described as a concomitant symptom. Intradural spinal tumors can be classified as intramedullary or extramedullary. Intramedullary tumors account for around 20% of intradural spinal tumors [4] and mainly comprise ependymomas (60%) and astrocytomas (30%). Extramedullary tumors account for up to 80% of intradural tumors and mostly comprise schwannomas (30%) and meningeomas (25%) [4]. The treatment of choice in patients with intradural spinal tumor is open microsurgery to establish a histopathological diagnosis and to decompress the neural structures. In patients with benign tumors like meningeoma (WHO I) or schwannoma (WHO I) a complete tumor resection should be aimed for, in order to reduce the risk of tumor recurrence [5,6].

In patients with intradural spinal tumor, back/neck pain is not commonly described as a concomitant symptom, such that in patients with both tumor and degenerative spine disease, any back/neck pain is typically attributed to the degeneration rather than the tumor.

The aim of the present retrospective investigation was to analyze the impact of microsurgery of intradural spinal tumor on back/neck pain in the presence of degenerative spinal disease in the same or adjacent spinal segments.

3. Patients and methods

3.1. Patient demographics:

Fifty-eight patients undergoing 58 consecutive surgical procedures for intradural spinal tumor were included in this retrospective study. Detailed analysis of their preoperative symptoms, tumor characteristics and surgical procedures was carried out. Fifty-seven of the 58 procedures were performed to address the tumor alone using various approaches. Twenty-seven of the 58 patients were diagnosed with intradural spinal tumor, back/neck pain as a leading symptom and degenerative spine disease in the same or adjacent segments based on neuroradiological findings. These 27 patients comprised the group under investigation in the present study.

There were 15 male (56%) and 12 female (44%) patients with a mean age of 57.4±17.8 years. Three patients (11%) had a history of spine surgery: one patient had undergone discectomy; another, tumor surgery; and the final one, single segment stabilization and fusion for degenerative spine disease prior to surgical tumor removal.

3.2. Pre- and early postoperative management:

Patients were seen in the outpatients department and underwent clinical, neurological and electrophysiological examination as well as neuroradiological examination (MRI, X-rays). Patients were admitted to the hospital one day before surgery for neurological examination and final anaesthesiological check and clearance for surgery. After surgery patients were observed on an intermediate care unit for 24 hours and afterwards transferred to the ward. Mobilization under physiotherapeutic observation started 1-2 days after surgery. Patients were hospitalized for one week before being discharged or transferred to a rehabilitation clinic, in the case of major neurological deficits.

3.3. Surgery and intraoperative multimodal neuromonitoring:

Surgery was performed under general anesthesia and patients were put in a prone position after application of the neuromonitoring electrodes. The tumor segment was localized using fluoroscopy. Before skin incision patients received antibiotic prophylaxis. The surgical approach included hemilaminectomy or laminectomy and laminoplasty. To reduce the tumor volume a Söring^{TM} ultrasound tissue ablation machine was used to minimize manipulation of the neural structures. Dura opening was always in the midline exposing both ends of the tumor and using sutures to keep the dura opening wide open.

Part of the tumor mass was sent for histological examination. In all patients gross total resection of the tumor was intended.

Multimodal intraoperative monitoring (MIOM) was performed by two board-certified neurologists (third and fourth authors) with at least fourteen years of neuromonitoring experience, using the protocol described by Sutter et al. [7,8].
In the case of deterioration of the neurophysiological parameters, the surgery was modified to prevent severe neurological deficit. This included the elevation of blood pressure, stopping of tumor removal, application of steroids and/or use of a different surgical approach.

3.4. Follow-up:

Patients were followed-up by board certified neurologists or neurosurgeons at the clinic's outpatient department at six weeks (6.3 ± 1.3 weeks), four months (4.8 ± 3.4 months) and one year (13.1 ± 7.6 months) after surgery. Further follow-up was carried out depending on clinical symptoms, histopathological findings and the existence of recurrent tumor. The follow-up at six weeks was a clinical follow-up only, whereas those at three months and one year also comprised clinical and neuroradiological (MRI) examinations.
Clinical symptoms, surgery characteristics and complications were evaluated from the surgeons' and the patients' perspectives using the Spine Tango Registry [9] and the Core Outcomes Measures Index (COMI) [10].

The Spine Tango registry and its accompanying documentation forms were first introduced in November 2002 by EuroSpine, in cooperation with the M.E. Müller Center at the University of Berne in Switzerland [9]. The aim was to standardize outcome measures in patients undergoing spinal surgery [11]. The Spine Tango registry Surgery and Follow-up forms contain questions regarding the surgical procedure, intraoperative and postoperative complications, underlying pathology, and neurological and clinical outcome from the perspective of the treating surgeon.

The COMI is a short, multidimensional outcome instrument, with excellent psychometric properties, used in monitoring the outcome of spinal surgery from the patient's perspective. The items that it contains were first described in the literature in 1998 [12] for use in individuals with back pain. The COMI has one question each on back pain intensity,

leg/buttock pain intensity, function, symptom-specific well being, general quality of life, work disability and social disability, and is scored as a 0–10 index. The questionnaire has been found to be feasible to implement on a prospective basis in routine practice [10], and as responsive as many longer spine outcome questionnaires [13]. The shortness of the COMI and its multidimensional nature make it an attractive option to comprehensively assess all patients within a given Spine Centre and hence avoid selection bias in reporting outcomes [10].

The Spine Tango Surgical form was completed by the surgeon over the time period from admission to discharge and the Spine Tango Follow-up form was completed at all postoperative follow-up examinations. The COMI questionnaire was completed by the patient pre-operatively and at 3 months, 12 months and 24 months postoperatively.

3.4. Imaging and classification of spinal degeneration:

Preoperative MRI imaging was performed using different MRI scanners (all Siemens, Philips or GE scanners with a magnetic field strength of at least 1.5 Tesla). Postoperative imaging was performed using a Philips Achieva 3 Tesla MRI scanner. Imaging was analyzed independently and blinded to the clinical outcome using standardized software (picture archiving and communication system, PACS) by board certified radiologists.
Spinal degeneration was classified due to the preoperative imaging examinations. Spondylarthritis was classified according to the Fujiwara classification [22], disc degeneration was classified according to the Pfirrmann classification [23] and vertebral body marrow changes were classified according to the Modic classification [24]. Severe degeneration of a spinal segment was stated if type 3 or 4 of Fujiwara, type 1-3 of Modic and Grad 4 or 5 of Pfirrmann classification was present.

3.5. Statistical analysis:

The statistical analysis was performed using Microsoft Excel (Version 2003) and SPSS software (Version 16.0). Tumor volume was calculated based on the diameter method (Tumor volume = 4/3 * Pi * ½x * ½y * ½z), where x, y and z are the maximum diameters in the three axis.

4. Results

4.1. Surgical procedures, tumor characterics and pathology

Overall, 58 patients underwent surgery for intradural spinal tumor between 03/2006 and 03/2011. Of these, 27 fulfilled the inclusion criteria for the present study; there were 15 men (56%) and 12 women (44%) with a mean age of 57.4 ± 17.8 years (Table 1). The tumors were located in the cervical spine in 10 patients (36%), the thoracic spine in 7 patients (25%) and the lumbar spine in 11 patients (39%). The mean tumor volume was 22324 mm^3 (1437-104720mm^3) and the mean tumor size, 14 x 12 x 29mm^3 (Table 2).
Tumor surgery included a mean of 1.44 spinal segments per patient. The largest tumor extended over 4 segments. In all patients a gross total resection was aimed for. This was achieved in 18 patients (67%). Subtotal tumor resection was possible in 7 (26%) patients (2 ependymoma, 3 meningeoma, astrocytoma, metastasis). In 2 patients (7%) tumor removal (vascular neoplasia, ependymoma) was stopped after deterioration of neurophysiological parameters at the stage of an extended biopsy.
The neurohistopathological workup revealed 5 patients (19%) with ependymoma (WHO I), 2 patients (7%) with ependymoma (WHO II), 1 patient (4%) with astrocytoma (WHO I), 9 patients (33%) with schwannoma and 6 patients (22%) with meningeoma. There were 4 patients with histopathological diagnoses of lymphoma, metastasis or hemangiopericytoma.
All 27 patients suffered from concomitant degenerative spine disease in the spinal segments of or adjacent to the tumor as described above (3.4.). There were 5 patients (19%) with spinal canal stenosis, 24 patients (89%) with spondylarthrosis and 24 patients (89%) with discopathy and osteochondrosis.
The two patients with malignant disease (lymphoma, metastasis) received further treatment after surgery. The patient with cervical spine metastasis underwent radiotherapy and the patient with thoracic spine lymphoma underwent chemotherapy.

4.2. Early postoperative course and complications:

The early postoperative course was uneventful in most patients. In the overall group of 58 patients there was 1 case of postoperative hematoma and 1 case of CSF leakage; however, within the study subgroup of 27 patients there were no surgical complications and no cases of symptomatic postoperative hematoma, infection or CSF leakage. During hospitalization 2/27 patients (7%) suffered from cardiac arrhythmias, 1 patient (4%) from pneumonia, 1 patient (4%) from postoperative symptomatic transitory psychotic syndrome and 2 patients (7%) from transitory bladder dysfunction. There were no newly developed neurological deficits with the study population.

4.3. Preoperative symptoms, follow-up of symptomatology and COMI data (Table 3, 4)

Before surgery back/neck pain was present as a leading symptom in all 27 study patients (100%); radicular pain was present in 12 patients (44%), sensory deficits in 17 patients (63%), paresthesia in 13 patients (48%) and motor deficits in 14 patients (52%). Tumor surgery improved the symptomatology, and at one year follow-up only 9 patients (33%) complained of persisting back/neck pain, 1 patient (4%) of radicular pain, 9 patients (33%) of sensory deficits, 5 patients (19%) of paresthesia and 5 patients (19%) of motor deficits (Table 3). No patients developed new neurological symptoms.

Evaluation of the COMI questionnaires showed similar results to those reported by the patients during postoperative examination above. In the complete study group the mean preoperative COMI score for back pain was reduced from 3.8 ± 3.2 before surgery to 2.0 ± 2.2 at the 3-month follow-up and 2.2 ± 1.1 at the one-year follow-up. The mean COMI score for leg/arm pain reduced from 5.3 ± 3.2 before surgery to 2.6 ± 2.8 at the 3-month follow-up and 2.4 ± 2.7 at the one-year follow-up. Mean COMI Quality of Life score improved from 3.6 ± 0.9 to 2.2 ± 1.1 and 2.1 ± 1.1. The mean COMI score was 6.5 ± 2.3 before surgery and 3.2 ± 2.6 and 2.8 ± 2.6 at the three-month and one-year follow-ups respectively (Table 4).

For further evaluation of the data we divided the study population into two groups – one with postoperative persisting back/neck pain (P-group) according to what patients reported during postoperative consultation and one without (no-BP-group). Both groups showed statistically significant improvement of the mean COMI scores for quality of life (Figure 1). Regarding back/neck pain the self-rated COMI showed the same results as what patients reported during follow-up. The mean COMI score for back pain was reduced significantly in the no-BP-group from 4.2 ± 3.6 before surgery to 1.7 ± 1.7 and 1.7±1.7 at the three-month and one-year follow-ups respectively (Figure 1). In the BP-group the score remained around the preoperative level of 3.0 ± 2.2 (2.7 ± 2.8 and 3.4 ± 3.2 at the three-month and one-year follow-ups respectively).

Evaluation of various patient characteristics in the BP-group and no-BP-group revealed no significant group differences with respect to male/female ratio, mean tumor volume, tumor pathology and extent of surgery.

4.4. Tumor control, neuroradiological follow-up and necessity of treatment for degenerative spine disease

Patients included in the present study group had follow-up examinations over a mean period of 31 months. MRI studies were carried out at the 3-month and one-year follow-ups and annually thereafter. Altogether, 23/27 patients (85%) were in complete remission regarding tumor growth. Three patients were foreseen for radio-/chemotherapy due to progression of the tumor remnant (metastasis, astrocytoma, lymphoma) and one patient is scheduled for reoperation due to tumor regrowth (ependymoma).

Over the follow-up period after tumor surgery, only two patients (7%) required further treatment for back/neck pain and degenerative spine disease. One was treated with an epidural infiltration and one underwent surgery (stabilization and fusion) for single segment lumbar degeneration. Both patients were in the group with complaints of persisting back/neck pain after tumor surgery. For the other 7 patients in this group, the persisting back/neck pain had only a minimal effect on their quality of life and they underwent non-invasive treatment such as medication or physiotherapy.

5. Illustrative cases:

A 73-year-old patient presented with neck pain, headache, non-specific vertigo, left sided radiculopathy and mild left sided motor weakness (M4/5) of the upper limbs. Tumor surgery through a laminoplasty of C6 was performed and histopathological diagnosis revealed a Schwannoma (WHO I). Postoperative imaging studies showed no tumor remnant or recurrence (Figure 2) and the patient was in remission for 35 months. The neurological deficits recovered completely. The neck pain improved to the extent that no invasive therapy was necessary despite the severe degeneration of the cervical spine.

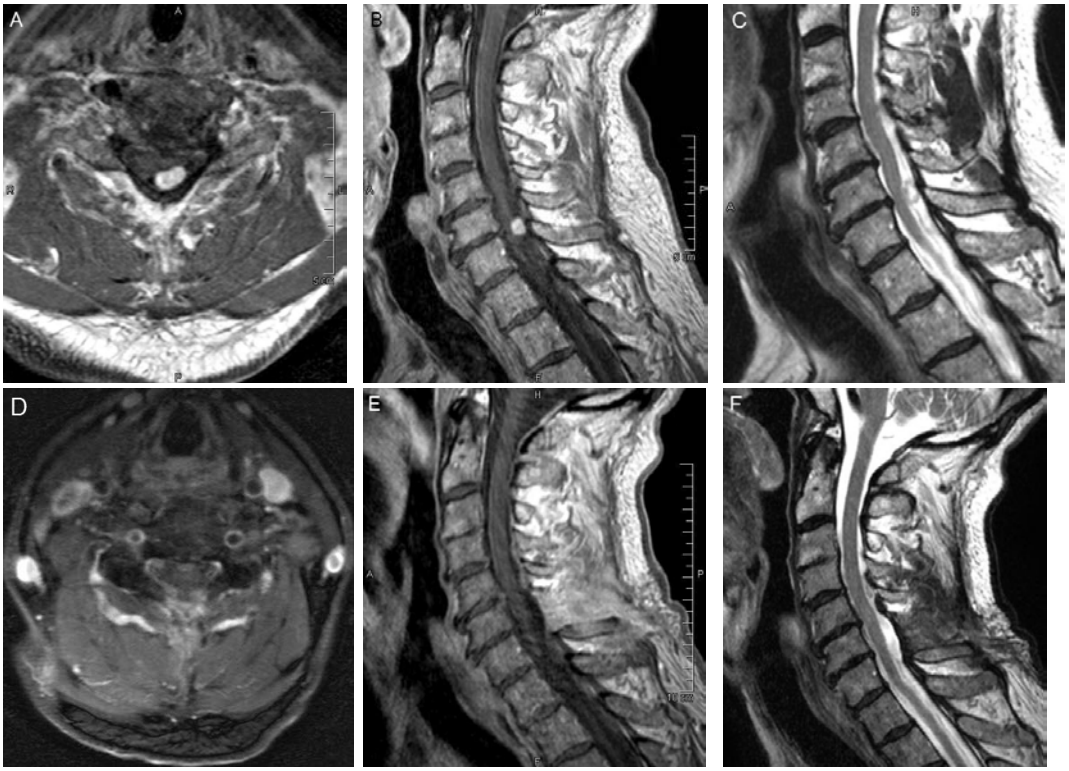


Figure 2: Illustrative case of 73-year-old patient with a cervical schwannoma level C6/7 and cervical multi-level discopathy and spondylarthrosis.

Preoperative MRI study:

A-C: Preoperative MRI study (T1 contrast enhanced axial, sagittal, T2 sagittal)

D-F: Postoperative MRI study (T1 contrast enhanced axial, sagittal, F: T2 sagittal)

A 60-year-old patient presented with severe back pain, and mild sensory and motor (M4/5) deficits of the lower limbs. Laminectomy at L3 and intradural tumor removal were

performed. The histopathological diagnosis was a schwannoma (WHO I). Postoperative MR imaging showed no tumor remnant or recurrence (Figure 3) and the patient was in remission for 19 months. Postoperative clinical examination showed complete remission of back pain and neurological symptoms. So far the concomitant degeneration of the adjacent lumbar segments at the levels L2/3 and L4/5 has been asymptomatic.

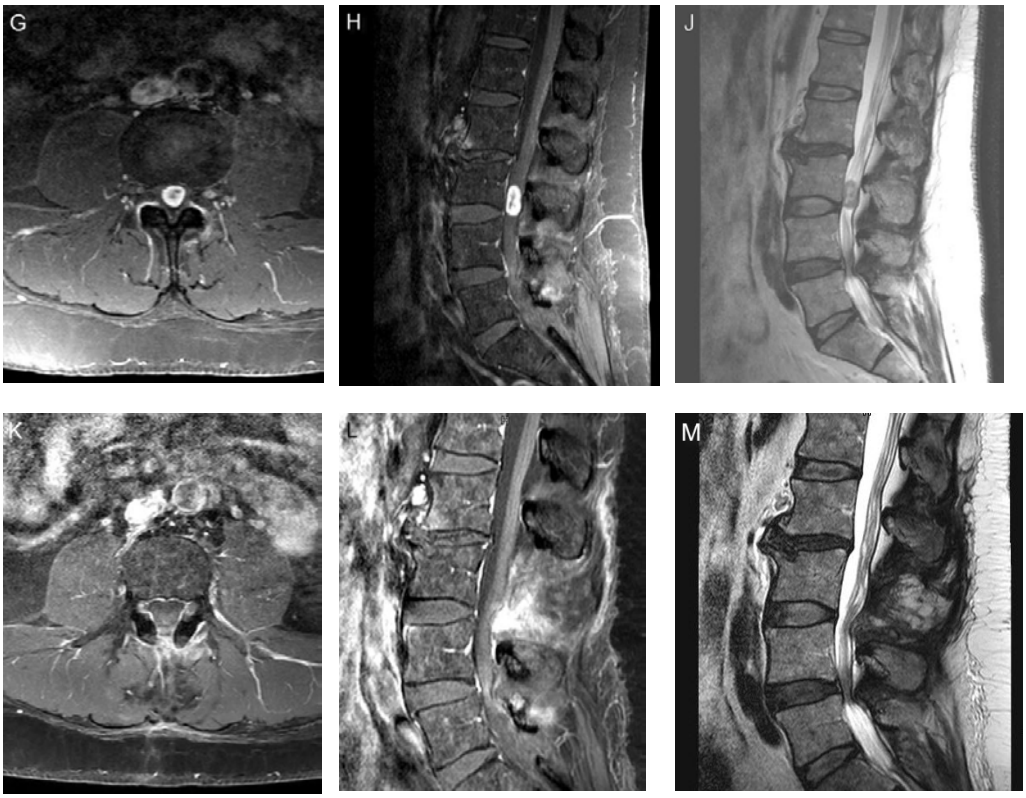


Figure 2: Illustrative case of 60-year-old patient with lumbar schwannoma level L3/4, lumbar spinal canal stenosis level L4/5 and discopathy and spondylarthrosis level L2/3.
G-J: Preoperative MRI study (T1 contrast enhanced axial, sagittal, T2 sagittal)
K-M: Postperative MRI study (T1 contrast enhanced axial, sagittal, T2 sagittal)

6. Discussion:

The present study analyzed the characteristics of intradural tumor surgery in patients with coexisting severe degenerative spinal disease and back/neck pain as a leading symptom. It demonstrated that surgery for intradural spinal tumors alone – despite the presence of severe degenerative spinal disease – avoids overtreatment of patients and that undertreatment seems to be rare.

Comparison of the results with previously published data shows that laminectomy/laminoplasty and microsurgical intradural tumor removal assisted by multimodal intraoperative neuromonitoring is a safe and very efficient treatment option concerning neurological symptoms and complications as well as tumor control. A remission rate of 85% and a rate of surgical complications of 0% is at least as good as in previous publications [5,6,14,15,16,17,18,19].

Surgical treatment of degenerative spinal disease in patients with intradural spinal tumor is controversial. Coexisting spinal canal stenosis, disk herniation, osteochondrosis or facet joint arthrosis can be treated during the same intervention. However, preoperative evaluation of the cause of symptoms, especially back pain, is difficult such that the surgical overtreatment of patients is also a distinct possibility. All of our study patients showed back/neck pain as a leading preoperative symptom and severe spinal degeneration as a comorbidity. In such situations one might typically attribute the back pain to the degeneration rather than to the tumor itself. However our results showed that with intradural tumor surgery only, back/neck pain was resolved in 67% of the patients and of the remaining 33%, only two patients (7%) needed further invasive therapy for degenerative spinal disease. Hence, performing only intradural tumor surgery led to a maximum of 7% of patients being undertreated and 26% of patients possibly having a less-good outcome than if they had been treated for degenerative spinal disease as well. On the other hand we would have overtreated 67% of patients if a surgical treatment for the degenerative spinal disease had automatically been performed in addition to that for the tumor removal.

There is only one publication addressing this differential, diagnostic dilemma. Börm et al. published a series of 10 patients which were treated and diagnosed for degenerative spinal disease and after more detailed diagnostics spinal tumors were found [25]. Most of the patients in the series were treated with tumor surgery alone as well. They concluded that with patients with intraspinal tumors adding up to 0.5% of their patients treated for spinal degeneration, further diagnostics are necessary if symptoms do not match with imaging findings.

Other previously published series have discussed the problem of progression of degeneration after tumor surgery [20]. It was found that there was no short-term difference between laminectomy or laminoplasty as far as progression of deformity following tumor

surgery was concerned [20]. However, there is some evidence that patients undergoing a more than two-segment laminectomy for tumor surgery have a high risk of developing instability and requiring stabilization and fusion [21].

There are some limitations of the study that need to be mentioned. The present study is a retrospective study of mainly prospectively collected data and patients were followed only for a mean time of 13 month. Another limitation is that two patients underwent further therapy with radio- or chemotherapy, which could potentially interfere with symptoms of back/neck pain. Those two patients were without back/neck pain after surgery.

The results of the present study and evidence from the literature show that in patients with degenerative spinal disease and intradural spinal tumor with back/neck pain as a leading symptom, tumor surgery alone is a safe and effective treatment modality. The data imply that intradural spinal tumor may be the main cause of back/neck pain more often than has hitherto been appreciated. Our results show that overtreatment for concomitant degenerative disease seems to be a higher risk than undertreatment but we could not identify factors predicting the necessity for further treatment for degenerative spinal disease. Undertreatment is nonetheless a rare but existing problem. It is essential to identify the factors that might predict the need for further treatment in order to provide patients with multiple pathologies with an individual treatment option that addresses only their specific symptomatic pathology.

7. Conclusions:

Tumor surgery for intradural spinal tumors improves back/neck pain in the majority of patients with coexisting severe degenerative spinal disease. Intradural spinal tumors seem to be the only cause of back pain more often than is appreciated. In these patients surgical overtreatment seems to be a greater risk than undertreatment. Therefore elaborate clinical and radiological examinations should be performed preoperatively and the indication for stabilization/fusion should be discussed carefully in patients foreseen for first time intradural tumor surgery.

8. Tables and figures:

8.1. Tables:

Table 1: Patient demographic and clinical data

Variable	Mean ± SD, or absolute number (%)
Number of patients/surgical procedures	58
Study group: patients with intradural spinal tumor, DSD and back pain	27
Number of surgical procedures	27
Sex (male/female)	15 / 12 (56% / 44%)
Mean age in years	57.4 ± 17.8
Mean duration of hospitalization in days	9.7 ± 3.1
Localization of tumor	10 CS (37%),7 ThS (26%),10 LS (37%)
Histopathological diagnosis	
Ependymoma (WHO I)	5 (19%)
Ependymoma (WHO II)	2 (7%)
Astrocytoma (WHO I)	1 (4%)
Schwannoma (WHO I)	9 (33%)
Menigeoma (WHO I)	6 (22%)
Other (Lymphoma, Metastasis, Hemangiopericytoma)	4 (15%)
Mean tumor volume (mm^3)	22324 (1437-104720)
Previous surgery	3 (11%)

Table 2: Surgical procedures and preoperative neuroradiological findings

Variable	Mean ± SD, or absolute number (%)
Segments per surgical procedure	1.44
Gross total tumor resection	18 (67%)
Subtotal tumor resection	7 (26%)
Extended biopsy	2 (7%)
Tumor volume (mm^3)	22324 (1437-104720)
Mean diameter (mm)	39.2 ± 44.4
Same/adjacent segment degeneration	27 (100%)
Spinal canal stenosis	5 (19%)
Spondylarthrosis	24 (89%)
Discopathy / osteochondrosis	24 (89%)

Table 3: Clinical and neurological symptoms before and 1 year after tumor surgery

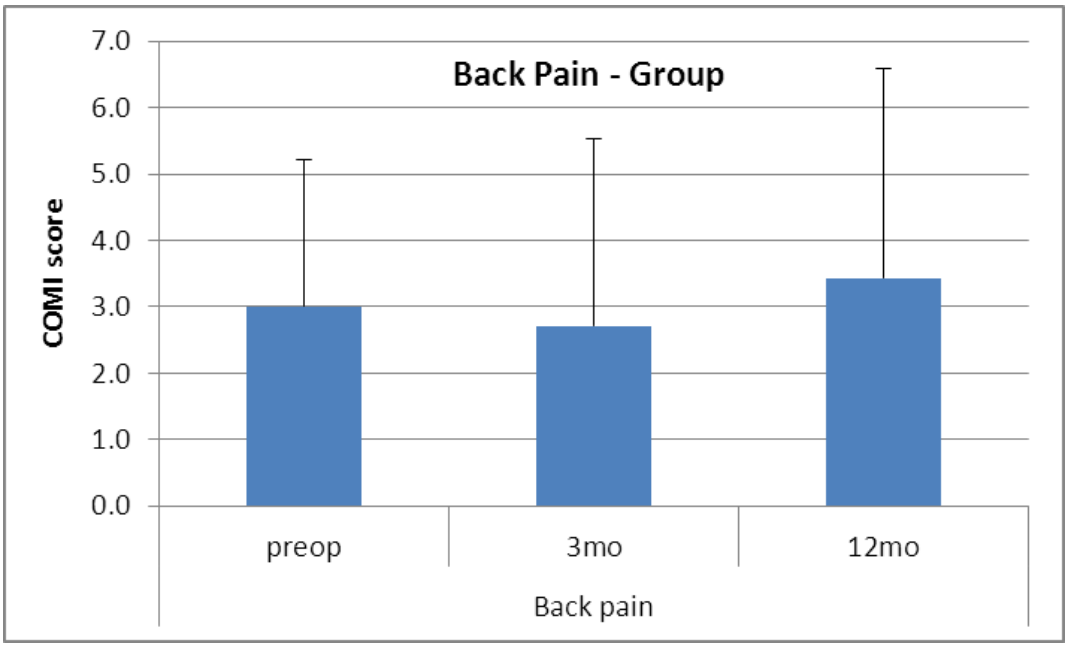
	preoperative	postoperative (1 year follow-up)
Back / neck pain	27 (100%)	9 (33%)
Radicular pain	12 (44%)	1 (4%)
Sensory deficit	17 (63.0%)	9 (33%)
Paresthesia	13 (48%)	5 (19%)
Motor deficit	14 (52%)	5 (19%)

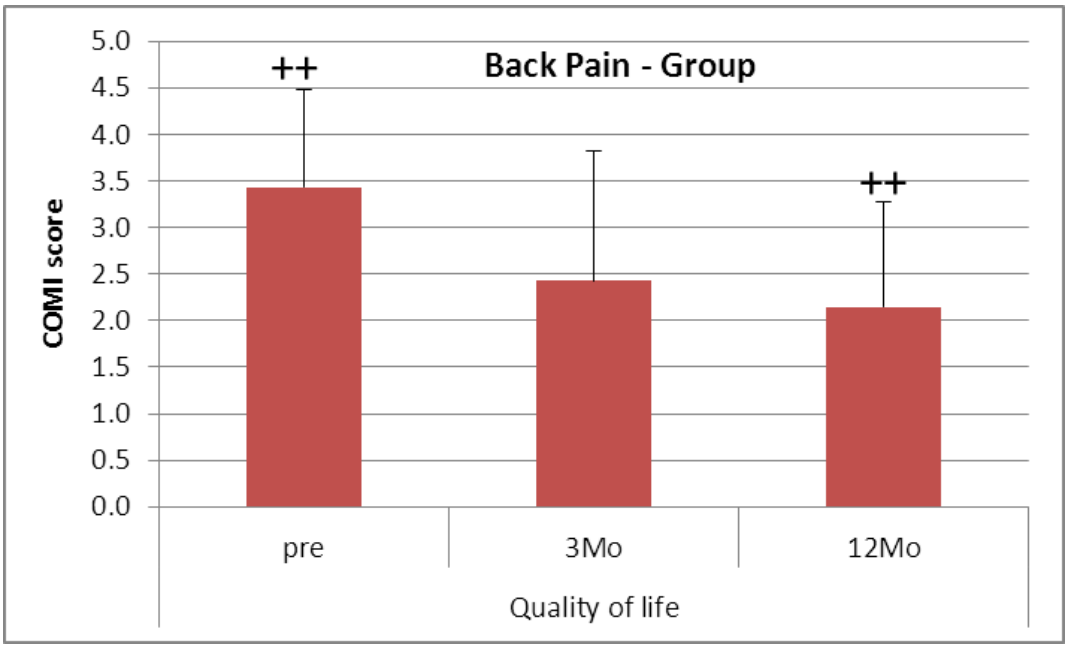
Table 4: Core Measures Outcome Index (COMI) data

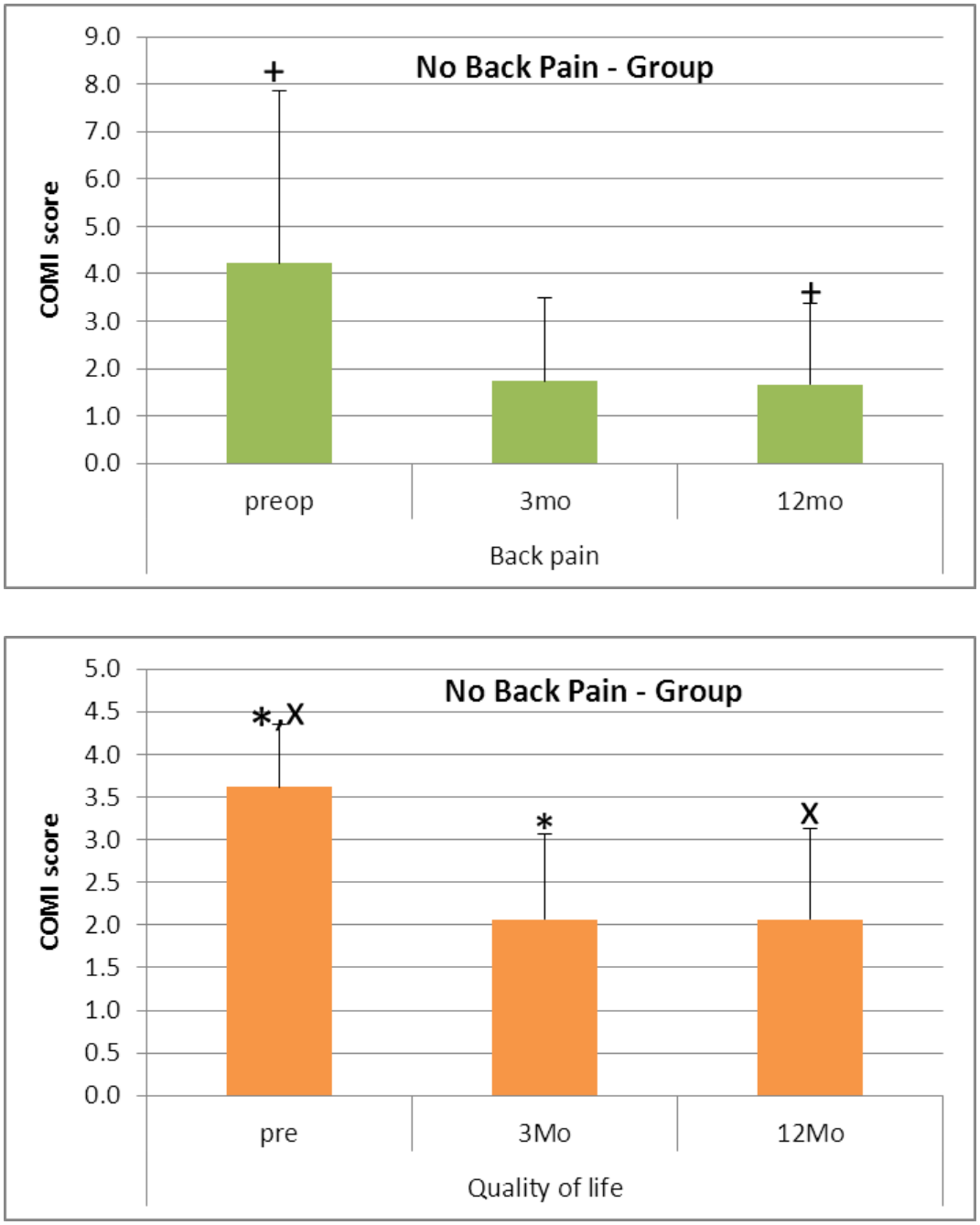
Table 4: (COMI and Spine Tango Registry data; complete study group)

	BP (COMI) Mean ± SD	EP (COMI) Mean ± SD	QL (COMI) Mean ± SD	COMI Mean ± SD
Preop	3.8 ± 3.2	5.3 ± 3.2	3.6 ± 0.9	6.5 ± 2.3
3m FU	2.0 ± 2.2	2.6 ± 2.8	2.2 ± 1.1	3.2 ± 2.6
1y FU	2.2 ± 1.1	2.4 ± 2.7	2.1 ± 1.1	2.8 ± 2.6

Figure 1: COMI data of “Back pain” and “No Back Pain” groups:







8.2. Figure legends:

Figure 1: COMI data of Back Pain and No Back Pain groups showing COMI scores for back pain and quality of life preoperatively and at 3 and 12 month follow up. (p-values: + = 0.035; x =0.001; ++ = 0.034; * = 0.001).

Figure 2: Illustrative case of 73-years-old patient with a cervical schwannoma level C6/7 and cervical multi-level discopathy and spondylarthrosis.
Preoperative MRI study:
A-C: Preoperative MRI study (T1 contrast enhanced axial, sagittal, T2 sagittal)
D-F: Postoperative MRI study (T1 contrast enhanced axial, sagittal, F: T2 sagittal)

Figure 3: Illustrative case of 60-years-old patient with lumbar schwannoma level L3/4, lumbar spinal canal stenosis level L4/5 and discopathy and spondylarthrosis level L2/3.
G-J: Preoperative MRI study (T1 contrast enhanced axial, sagittal, T2 sagittal)
K-M: Postperative MRI study (T1 contrast enhanced axial, sagittal, T2 sagittal)

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